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Observations on Parasitism of Pelagic Juvenile Fish

Dr. Ludwig Scheuring[1)]

Symbiosis and parasitism are two types of associations with many transitional stages which make it often difficult for an observer to decide in favour of one over the other. The range of variations among symbiotic relationships and the wealth of possible parasitic modes make it even more difficult to distinguish between symbiosis and parasitism. In symbiosis, it is extremely rare when both symbionts of a partnership derive the same amount of benefit from it; it is much more common for one symbiont to benefit at the expense of the other. If this ratio is shifted more and more in favour of one symbiont, we finally arrive at relationships which approach either endo- or ectoparasitism and may eventually result in true parasitism. Consequently, we need very accurate observations of both symbionts in their natural environment and suitable experiments to determine whether it is symbiosis or parasitism we are dealing with in a particular case.

[1)] This article was submitted to the Biol. Centralbl. [Biological Central Journal] in November 1913; unfortunate circumstances prevented an earlier publication, contrary to the author's wishes.

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The following account focuses on the association of two organisms, the nature p. 182
of whose interrelationship has remained conjectural.

During the summer, jellyfish (Cyanea capillata and Aurelia aurita) are on display in one of the large basins in the aquarium of the Biological Institute on Heligoland. Small fish may frequently be observed playing under the umbrella and among the long tentacles of Cyanea, apparently completely oblivious of the thread cells with which the long tentacles are armed. The fish are juvenile Gadus merlangus and Caranx trachurus, both of which usually stay beneath the umbrella of the jellyfish or remain close by.

The purpose of this strange behaviour was unclear. It was generally believed that the association of juvenile fish and jellyfish was one of "ideal companionship": The jellyfish offers the vulnerable fry protection under and behind its tentacles armed with thread cells and even allows the fish to feed on the abundant small plankton adhering to its tentacles, while the fish rids the jellyfish of parasitic amphipods (Hyperia galba) which are embedded in the umbrella. However, this interpretation has frequently been regarded as speculative and highly questionable; in most cases, the association of fish and jellyfish was not examined further and it was merely mentioned that the occurrence of juvenile fish depended on the presence of the jellyfish.

The literature dealing with the association of fish and jellyfish is very scant and widely scattered. As a result, I may well have missed one or the other source, all the more so since such references are often contained in larger works whose titles bear no relation to the subject at hand.

A. W. Malm was the first researcher who observed the occurrence of juvenile fish under jellyfish and who also commented on the kind of relationship between the two. In an article entitled "Om yngel af Caranx trachurus" [On the fry of Caranx trachurus], which appeared in Öfversigt af Kongl. Vetenskaps. Akademiens Förhandlingar. Attonde Argangen 1952 [Overview of the Reports of the Royal Academy of Sciences], he reported on p. 226 as follows[2]: "During my stay on the skerries in the Province of Bohus last summer, I heard from an old fisherman that whiting (Merlangus vulgaris) were born in jellyfish (Cyanea capillata); another fisherman assured me that jellyfish ate herring fry. p. 183

To investigate the matter, I collected and examined many jellyfish and found seven young specimens of Trachurus in one jellyfish, three in another and five in a third. They were all found between the ovaries of the jellyfish. And when I tried to catch the fry, they all fled as far as possible under the umbrella of the jellyfish. I conducted the following experiment with the last jellyfish I had obtained: After I had placed the fishes in a container filled with water, I released the jellyfish; and when I released one fish after another immediately afterwards, I noted with great pleasure that they all dived under the jellyfish, which had sunk by about two feet, and immediately sought shelter under its umbrella. I repeated the experiment, but four of my small fish died in the course of it and only the remaining one reached, as it seemed, his "beloved" jellyfish. Subsequently,

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*Translator's note: In a footnote, the author states that the quote from the above-mentioned article has been translated into German because very few people in Germany understand Swedish. Accordingly, the above English version is a translation of a translation.

I took the jellyfish and placed it in a boat lying halfway submerged on the shore and, during the three days I stayed in Christineberg, I often visited this jellyfish under whose ovaries the small fish gently moved about. When I examined the intestinal tract of the fish and found it full of jellyfish eggs, I was convinced that these small fish have a kind of parasitic relationship with Cyanea capillata. The reason for my bold assumption is that I have never seen these young fish other than near this species of jellyfish when I conducted more detailed experiments. It is also worth mentioning that I have never seen another species of fish near that jellyfish, although I encountered it occasionally among thousands of Gobius ruthensparri Euphras and other fishes. Horse mackerel fry moves at a very early stage between the ovaries of the jellyfish in order to feed and remain there until it has reached a more mature stage, this can finally be concluded from the fact that all individuals found in one jellyfish had about the same size."

Malm referred to these observations on page 421 of his well-known work entitled "Göteborgs och Bohusläns Fauna, Ryggradsjuren [Fauna of the Province of Göteborg and Bohus. Vertebrates], 1877, and added some additional information. He observed always the same phenomenon when he stayed in Christineberg in 1853, 1854 and 1873, namely he always found young horse mackerel under Cyanea capillata. Only on one occasion did he find them also under Rhizostoma aldrovandii and was inclined to view this as an exception due to a mistake made by the fish. On page 485 he stated for the first time that fry of Gadus merlangus also lived in association with the jellyfish. "In summer, I often saw several specimens (i.e. young Gadus merlangus) from the shore or from a boat ... I observed them in the clear water as they followed the jellyfish Cyanea capillata in exactly the same way as the fry of Caranx ... p. 184

On 3 June 1856 near Känsö, I noted* several young fish of 19-30 mm length keeping close to the above-mentioned jellyfish species; on 7 August 1865 near Strömstad, I saw fish of 15-30 mm length swimming in the same manner; and at the same location in the same year, I observed fish of 50-60 mm length, but these swam separate from the jellyfish."

Collet (1875) has reported that young specimens of Gadus morrhua seek protection under Cyanea capillata and Medusa aurita from the many dangers during their pelagic life (p. 106) and that the fry of Gadus aeglefinus and Gadus merlangus have been found together with Cyanea (pp. 108 and 109).

Möbius and Heincke mention in their well-known book "Die Fische der Ostsee" [The Fishes of the Baltic Sea] that the juvenile forms of Caranx, Gadus aeglefinus and Gadus merlangus are associated with Cyanea capillata. "Observations made by other researchers indicate that very young horse mackerel live in the gastrovascular cavities of jellyfish" (p. 216).

As far as Caranx is concerned, Smitt refers to Malm's observations in "A History of Scandinavian Fishes". These observations have been confirmed by I. W. Grill in his written comments to Eckström (pp. 87 and 88). Regarding the fry of haddock, we can read on p. 471: "Like the young of several other fishes, of the horse mackerel and the cod for example, the haddock fry according to Sars and Collett, seek shelter and food under the bodies of Medusae, together with which they drift about, until they are more than 50 mm long." According to Smitt, codling also seek shelter under the jellyfish: "The fry (10 - 15 days old) now seek shelter under Medusae and other floating

*Translator's note: Literally, "I received several young fish..."

objects" (p. 478). On p. 491, the author then discusses the relationship between young whiting and jellyfish and is the first to advocate the above-mentioned view that young Merlangus, as the "companion" of the jellyfish, rids it of its parasites ... "The fry may be seen assembled in fairly great numbers under the large jellyfish (Cyanea capillata) in which the sea abounds. Thus the fry of the whiting like those of the cod and other fishes, fly for shelter to these creatures and feed upon the crustaceans which live as parasites in the body of the jellyfish or adhere to its long, filiform, and slimy tentacles. During the summer ... small whiting from 10 to 12 mm long may often be seen keeping close to a jellyfish for hours, following its sluggish movements in a manner that seems to indicate a certain intimacy and mutual confidence between these strangely-assorted companions."

The International Oceanography publications frequently mention the occurrence of young Gadidae and Caranx in association with jellyfish and emphasize their dependence on the latter. However, the type of dependence existing between the two has not been examined in detail. p. 185

In "Eier und Larven von Fischen der Deutschen Bucht" [Eggs and Larvae of Fishes in the Deutsche Bucht], Heincke and Ehrenbaum clearly emphasize that although the association of fish and jellyfish has been known for a long time, its purpose is not yet sufficiently clear. "The juvenile forms of the horse mackerel have been known for a long time and have been frequently observed, particularly when they swarm in small groups around scyphozoan jellyfish of the genera Cyanea and Rhizostoma, with whom they maintain a relationship which has not yet been fully explained" (p. 277).

In "Eier und Jugendformen der Nutzfische der Nord- und Ostsee und die Altersbestimmungen der Nutzfische" [The Eggs and Juvenile Forms of Food Fishes in the North Sea and Baltic Sea and the Age Determination of Food Fishes], Heincke also stressed the fact that the occurrence of young fishes depended on that of jellyfish. "It is known that young whiting are almost invariably found together with jellyfish (mostly Cyanea) as long as the whitings are relatively small and live in the pelagic zone. It is not yet known whether this characteristic behaviour of the young fish of staying very close to the jellyfish, and, indeed, between their tentacles - as we have observed it frequently in our aquaria and occasionally in the open sea close to the water surface - is a type of true partnership and if so, which type of partnership. It is certain that we have almost never caught pelagic whitings in our surface nets without catching jellyfish at the same time and that the number of whiting in a catch was proportional to the number of jellyfish. Incidently, lack of observations precludes us from determining to what extent young fishes of other species of Gadidae, for example, young haddock and cod, live in association with jellyfish; we only want to stress here that every catch of pelagic young fishes contained jellyfish and that haddock and cod, when caught, always occurred in conjunction with whiting which almost invariably outnumbered the other two species" (p. 39).

The same researcher comments in similar terms in the third annual report entitled "Die Arbeiten der Kgl. Biologischen Anstalt auf Helgoland in der Zeit vom 1. April 1904 bis 31. März 1905" [The Works of the Royal Biological Institute on Heligoland between 1 April 1904 and 31 March 1905]: "Of particular interest is the strange dependence of the fry of certain gadoid fishes, such as cod, haddock and whiting, on the occurrence of jellyfish, specifically the genus Cyanea, as we have noted in our studies. When the fry of these species

has completed the larval stage, it remains for some time in the pelagic zone in open water and only gradually adopts life at the sea bottom. Whiting is the last to do so, while cod is the first to become a bottom dweller. During their pelagic life, these three fish species are encountered almost exclusively in association with the above-mentioned jellyfish and are seen swimming in close proximity to them and between their tentacles. This strange partnership of fishes and jellyfish, whose true significance has not yet been determined, is such a close one in the North Sea that in locations where there are no jellyfish we have almost never found young fish of the species mentioned. For days we sailed far from shore in the northwestern North Sea without seeing jellyfish or catching a pelagic young gadid; however, as soon as the first jellyfish were sighted, we would also find these fish.

Since jellyfish are mainly plankton eaters and probably drift over large distances with the currents, it must be assumed that the distribution of the fry of cod, haddock and whiting may also be affected in large measure by currents."

The following comments regarding whiting appear a few pages later: " ... When they are 2-5 cm long, they live in the summer months in huge shoals in association with jellyfish in the surface and subsequent layers of the sea and frequently remain there even after they have grown to a size of ten, fifteen and more centimeters" (p. 79).

While Heincke and Ehrenbaum did not advance any specific theory on the type of partnership between juvenile fish and jellyfish, other authors have advocated the view that the juvenile fish seek shelter under the jellyfish.

Griffini, for example, comments in his "Ittiologia italiana" [Italian Ichthylogy] regarding Caranx: "It has been observed that young fish sometimes follow the large medusae, seeking shelter under their umbrellas, and thus finding protection among the stinging organs of these coelenterates" (p. 408).

T. W. Bridge and G. A. Boulenger have also adopted this view in their treatment of fishes in "The Cambridge Natural History" where they state: "The young ... of Caranx trachurus keep together in small bands in the neighbourhood of medusae, under which they seek shelter when disturbed."

An association of juvenile fishes and jellyfish exists not only in the families Gadidae and Carangidae. For example, the family Stromateidae has many species which are found in association with jellyfish. Physalia has been known to be p. 187 frequently accompanied by a species of this family, namely Nomeus gronovii Gmelin. Waite reports on this as follows in Rec. Austral. Museum, Vol. 4, p. 39: "It is noticed that Nomeus is only found on our coast, when the 'Portuguese men-of-war' are driven ashore, and this is quite in accord with the habit of the fish in swimming beneath the Physalia." Waite provides the following comments on p. 10 on the nature of the interrelationship between the two: "The relationship which exists between Nomeus and Physalia is a very curious one, and invites speculation as to the advantage of the association. A similar partnership is known between fishes and medusae. The benefit must be primarily with the fish, for it is a voluntary agent, whereas the Physalia has no power of locomotion. If the fish secures safety from its enemies by entering the area embraced by the deathly tentacles of the Physalia, which attains a length of ten to twelve feet, it must be immune to their influence; a remarkable condition considering, as I have previously recorded, that small fish have often

been seen in their stomachs and entangled in their tentacles" (Waite, Austral. Museum Mem. Vol. 4, 1899, p. 15[3]). With respect to feeding as well, the fish derive, in his view, the greater benefit from the association with the jelly-fish. "It is probable that, in addition to protection, the fish derives its food from association with Physalia ... The Physalia doubtlessly paralyzes many more animals than it can consume. - The residue falling to the lot of the fish, which may be present to the number of ten" (p. 41).

I conducted a number of observations and experiments in the basins of the Biological Institute to finally clarify the behaviour of young fish relative to jellyfish. I used mainly young whiting and Cyanea capillata for these experiments and verified only the most essential findings on young Caranx.

Jellyfish keep in the basins only for relatively short periods and therefore must be replaced frequently. On such an occasion I noted that the fish in the basin rushed towards fragments of ovaries, which had been torn from the jellyfish during transport, and devoured them. This behaviour gave the distinct impression that this was their normal food which they, of course, preferred. I found support for this interpretation in the fact that raising fry of whiting together with jellyfish is nearly always successful, while more fish tend to die when they are kept separate from jellyfish even when they are fed p. 188 regularly and abundantly with fresh plankton. When I observed the fish further, I noticed often enough that after they had fed on all torn off and floating ovary fragments, they attacked the genital cavities of the jellyfish and pulled out clusters of eggs. But the fish did not only attack the ovaries

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[3] However, according to Garman (Bull. Lab. Nat. Sc. 1896, p. 86), small Nomeus have also been frequently killed and eaten by Physalia.

of the jellyfish, but on numerous occasions pulled at the tentacles as well. However, I never observed that the fish paid any attention to the amphipods (Hyperia galba) which were present in all sizes and lived as parasites within the umbrella of the jellyfish.

When I examined the stomach of a fish which had been in the company of jellyfish for several days, I found its digestive organs completely filled with fragments of ovaries and tentacles, but no trace of Copepoda or other crustaceans, although the jellyfish (and consequently the fish as well) were amply fed with plankton every day and small dead crabs were frequently attached to their tentacles.

I subsequently separated several fish of different sizes from the jellyfish, kept them without food for 1-2 days, and subsequently fed them with ovary fragments. The fish devoured them rapidly and in such quanties that their bodies clearly showed their distended stomachs.

After another starvation interval, the fish were fed a mixture of ovary fragments and small live crustaceans (Copepoda and decapod larvae). Again, the young whiting rushed towards the ovary fragments, while completely ignoring the crustaceans.

The thoroughly starved fish were then given relatively large amounts of Hyperia galba in all sizes. But again, not a single amphipod was later found in the stomachs of the young whiting.

Most of the fish rejected pure plankton fed to them; only the relatively large specimens (over 9 cm) accepted a few crustaceans after some hesitation but, as

it seemed, merely because they were driven by hunger, rather than eagerness and preference for that particular food. The youngest fish, moreover, refused to accept plankton altogether.

All these experiments were repeated several times and some were verified on Caranx. They confirm that young whiting and horse mackerel must be regarded as true parasites of the jellyfish. They feed exclusively on pieces of the jellyfish's body. Therefore, Malm's assumption in this regard was correct. The jellyfish does not derive any advantages from the partnership with the fish since they reject the jellyfish's parasites as food; consequently, the relationship between jellyfish and fish is not a companionship, it is not symbiosis, but rather parasitism. p. 189

If we ask ourselves how and why parasitism may have evolved in juvenile fish relative to jellyfish, the reason may well be their adaptation to pelagic life combined with a stigmotactic escape instinct.

Many juvenile fish in their natural environment are only found under floating algae, etc. These provide shelter and food; when larvae are being preyed upon, they disappear quickly under and among the tangle of stalks and stems and the organisms adhering to or crawling on the plants are their main source of food. However, drifting masses of seaweed are always encountered nearer to the shore than on the open sea. Consequently, extremely pelagic larvae will not find enough shelter under such floating masses of seaweed on the open sea. These larvae adapt to the presence of the purely pelagic jellyfish, which also float in the water, and seek shelter and food from them in the same way as their relatives find shelter and food among algae.

The behaviour of juvenile members of various gadid species provides good support for the probable evolution of parasitism as outlined above.

Juvenile forms of Gadus pollachius are not pelagic and are invariably caught under and among algae close to the shore. Gadus virens has already a certain tendency to live in open water; its larvae occur mainly under drifting masses of seaweed. Gadus morrhua is pelagic in the juvenile stages, but moves soon to the bottom and the seaweed zone. Its fry is mainly encountered under drifting algae, but occurs occasionally also under jellyfish. Haddock[4] becomes a bottom dweller later than codling. Consequently, haddock larvae prefer the association with jellyfish, although they are also quite common under masses of drifting algae. Whiting is the most pelagic among the gadids. Its fry has adapted completely to the parasitic relationship with the jellyfish and is no longer capable of feeding on small crustaceans like its relatives (compare Heincke's observation quoted above).

My experiments did not touch on the question whether juvenile fish are immune to the thread cells of the jellyfish. I might only speculate that such absolute immunity of the fish need not be assumed, although the mouth and throat of the fish must be immune to the effect of the thread cells since after all, the fish feed on the tentacles. Moreover, fish can frequently be observed to avoid contact with the stinging threads through their skilful body movements. Also, it is questionable whether the stinging threads are powerful enough to penetrate the relatively thick mucilaginous epidermis of the fish during a possible contact. p. 190

[4] Unfortunately, I had no opportunity to conduct experiments with young Gadus aeglefinus to determine whether they accept plankton, and, specifically, small crustaceans, as food.

Literature

1. Bridge, T. E. and Boulenger, G. A. 1904. Fishes. In: Cambridge Natural History, Bd. 7.
2. Collet, R. 1875. Norges Fiske med Bemaerkninger om deres Udbredelse, Trykt som Tillaegsh. til Vidensk. Selsk. Forh. f. 1874.
3. Griffini. 1904. Ittiologia italiana.
4. Heincke, Fr. und Ehrenbaum, E. 1900. Eier und Larven von Fischen der Norddeutschen Bucht. In: Wiss. Meeresunters. N. F., Abt. Helgoland, Bd. 3.
5. Heincke, Fr. 1905. Die Eier und Jugendformen der Nutzfische der Nord- und Ostsee und die Altersbestimmungen der Nutzfische. In: Rapports et Procès-verbeaux, III. Gesamtbericht, Anlage E.
6. — 1906. Die Arbeiten der Kgl. Biologischen Anstalt auf Helgoland im Interesse der Internat. Meeresforschung in der Zeit vom 1. April 1904 bis 31. März 1905. In: Die Beteiligung Deutschlands an der Internat. Meeresforschung. III. Jahresbericht.
7. Malm, A. W. 1852. Om yngel af *Caranx trachurus*, in Öfersigt af Kongl. Vitensk. Akad. Förh. Åttonde Årgången 1852.
8. — 1877. Göteborgs och Bohusläns Fauna, Ryggradjuren.
9. Möbius, K. und Heincke, Fr. 1883. Die Fische der Ostsee. Kiel.
10. Smitt, F. A. 1893. A History of Scandinavian Fishes, II. Ed.
11. Waite, E. R. 1908. Additions to the Fish-Fauna of Lords Howe Islands, Nr. 2. In: Rec. Austral. Mus. Bd. IV, 1901—1903.

Translation of non-English bibliographical entries

2. Fishes of Norway with notations of their distribution, printed as an addendum to the Reports of the Learned Society 1874.

3. Italian ichthyology.

4. Eggs and larvae of fishes of the Deutsche Bucht.

5. The eggs and juvenile forms of food fishes of the North Sea and Baltic Sea and the age determination of food fishes.

6. The works of the Royal Biological Institute on Heligoland on behalf of International Oceanography from 1 April 1904 to 31 March 1905. In: Germany's participation in International Oceanography. 3rd annual report.

7. On fry of Caranx trachurus, in Synopsis of the Reports of the Royal Academy of Sciences, 8th annual volume, 1852.

8. The fauna of the Province of Götheburg and Bohus. Vertebrates.

9. The fishes of the Baltic Sea.